

**APPLICATION FOR
UNITED STATES LETTERS PATENT
SPECIFICATION**

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SHEETS REVERSING CONTROLLER AND CONTROL METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority from the prior Japanese Application No. 2002-343248, filed on November 27, 2002; the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

2. Field of the Invention

[0002] This invention relates to a sheet reversing controller and a reversing control method for reversing (the switchback reversing) the conveying direction of sheets, for example, postal matters that are conveyed.

3. Description of Related Art

[0003] There is a reversing (switchback reversing) gear incorporated in a sheet processor for conveying and processing postal matters, etc. and for reversing the conveying direction of sheets conveyed.

[0004] For example, in the reversing gear disclosed in the Japanese Patent Application No. 1005-23284, there were such problems as described below. It is desirable to increase the conveying density of sheets and convey sheets without changing a conveying gap between sheets before and after the switchback reversing. However, the protruding amount of sheets from the entrance of the reversing portion when the conveyance of sheets is stopped varies depending on lengths of sheets. Therefore, it was so far difficult to design an installing position of a switching gate to a reversing path and a flap shape composing the switching gate.

[0005] The sheet length referred to here is the length of sheets in the conveying direction. Further, the conveying gap between sheets is a distance from the rear end of a sheet to the front end of a sheet that is next conveyed, and is also applicable in the following explanation.

[0006] Next, a conventional conveying control will be explained using FIG. 1.

[0007] FIG. 1A to FIG. 1D are diagrams showing a length L of a sheet protruding from a reversing roller 11 and a pinch roller 12 when the sheet 1 is conveyed in the arrow direction A and stopped in order for reversing its conveying direction (in the arrow direction B). Here, the length of the sheet 1 protruding from the reversing roller 11 and the pinch roller

·12 is shown when a conveying control parameter that is constant regardless of the length of the sheet 1 was used for the sheet in an optional length.

[0008] FIG. 1A shows that a protruding length of a sheet 1 that is suited to a detecting is L when the length of the sheet 1 is most short.

[0009] In FIG. 1B, a protruding length L1 becomes longer than L because the length of the sheet 1 is longer than the length of a sheet 1 shown in FIG. 1A.

[0010] In FIG. 1C, the protruding length L2 becomes longer than L1 because the length of the sheet 1 is longer than the length of the sheet 1 in FIG. 1B.

[0011] In FIG. 1D, the protruding length L3 becomes longer than L2 because the length of the sheet 1 is longer than the length of sheet 1 in FIG. 1C.

[0012] Thus, the longer the length of a sheet 1 becomes, the longer the protruding length becomes and comes close to the switching gate provided adjacent to the upper stream side in the conveying direction. Further, the sheet 1 also becomes close to the conveying path in the reversing direction and it becomes difficult to control the turning of the switching gate.

[0013] Therefore, the tolerance of variance in protruding amount of a sheet from the entrance of the reversing portion is subject to the installed position or the swing shape of the switching gate and becomes a narrow range. In order to restrict the variance of protruding amount of a sheet in a narrow range, it was necessary to make a conveying gap between sheets wide and afford a sufficient time to the switchback reversing. Because of this, there was such a problem that the conveying density of sheets could not be increased.

[0014] Further, when a protruding amount of sheet is made constant, the conveying gap between sheets changes before and after the switchback reversing and therefore, in order to avoid its effect, it becomes also necessary to make the conveying gap wide between sheets. Accordingly, there was such a problem that the conveying density could not be increased (the high density conveying) could not be made.

SUMMARY OF THE INVENTION

[0015] It is an object of this invention to provide a sheet reversing controller and a control method for controlling a conveying gap between sheets in the high density conveyance so that it remains unchanged before and after the switchback reversing of sheets by optionally setting a protruding amount of sheets from the entrance of the reversing portion when sheets are stopped within a certain range according to the installing position and the shape of a switching gate regardless of the length of sheets.

[0016] According to this invention, a sheet reversing controller is provided. This sheet reversing controller comprises a first conveying path to convey plural sheets in a first direction with a specified gap; a reversing portion arranged at the downstream in the conveying direction of the first conveying path, comprising a reversing roller capable of normal and reverse rotations to take and reverse the sheets fed from the first conveying path and a pinch roller arranged opposing to the reversing roller; a second conveying path to take and convey the sheets fed in a second direction differing from the first direction of the first conveying path by the reversing portion; and a controller to control the conveyance of the sheets so that the conveying gap between the sheets conveyed on the second conveying path becomes equal to the specified conveying gap when conveyed on the first conveying path regardless of lengths of plural sheets.

[0017] Further, according to this invention, a sheet reversing control method is provided. This sheet reversing control method comprises conveying plural sheets on a first conveying path in a first direction with a specified gap; taking and reversing the sheets fed from the first conveying path in a reversing portion arranged at the downstream in a conveying direction of the first conveying path comprising a reversing roller that is capable of normal/reverse rotation and a pinch roller arranged opposing to the reversing roller; taking the sheets in a second direction differing from the first direction after reversing by the reversing portion and conveying on the second conveying path; and controlling a conveyance of the sheets so that the conveying gap of the sheets conveyed on the second conveying path becomes equal to the specified gap when conveyed on the first conveying path regardless of the lengths of the plural sheets.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1A to FIG. 1D are schematic diagram showing a length of a sheet protruding from the reversing roller and a pinch roller by an existing conveying control, respectively;

[0019] Fig. 2 is a sectional side view of a sheet reversing gear showing an embodiment of this invention;

[0020] FIG. 3 is a block diagram showing the construction of a control circuit of a reverse controller;

[0021] FIG. 4 is a schematic sectional side view showing the moment when the rear end of a sheet changed from the dark state of a length sensor to the light state;

[0022] FIG. 5 is a schematic sectional side view showing the moment when the front end of a sheet reaches a timing sensor;

[0023] FIG. 6 is a schematic sectional side view showing the moment when the front end of a sheet reaches a nip between the reversing roller and the pinch roller;

[0024] FIG. 7 is a schematic sectional side view showing the moment when a sheet is stopped in the state protruding in a length L from the reversing roller and the pinch roller;

[0025] FIG. 8A to FIG. 8D are schematic diagrams showing a protruding length L of a sheet from the reversing roller and the pinch roller by the conveying control in the embodiment of this invention, respectively;

[0026] FIG. 9 is a schematic sectional side view showing the state of a sheet sent out in a second conveying path;

[0027] FIG. 10A to FIG. 10C are diagrams showing velocity patterns relative to a reversing roller drive control; and

[0028] FIG. 11 is a schematic diagram for explaining the sheet conveying state before and after the reversing.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0029] A preferred embodiment of this invention will be described below referring to the attached drawings.

[0030] FIG. 2 is a schematic sectional side view of a reversing controller of sheets showing an embodiment of this invention. A sheet 1 is a medium being conveyed such as a postal matter.

• **[0031]** The reversing controller is composed of a first conveying path 4, a length sensor SCO1, a timing sensor SCO2, a switching gate 5, a reversing portion 10, a conveying roller 6, and a second conveying path 7. The switching gate 5 has a flap shape to oscillate centering around a pivot 5a provided coaxially on the rotary shaft of the pinch roller 3 that will be described later.

[0032] The first conveying path 4 conveys the sheet 1 in the first direction that is the arrow direction A.

[0033] The length sensor SCO1 is arranged in the first conveying path 4 and detects a length of the sheet 1 arranged at the upper stream of the conveying path 4.

[0034] The timing sensor SCO2 is used to set up a conveying control timing of the sheet 1 arranged at the downstream of the conveying path.

[0035] The sensors SCO1 and SCO2 are composed of a light emitting element and a photo accepting element to receive a light from the light emitting element, respectively.

[0036] The length sensor SCO1 detects the length of the sheet 1 being conveyed by measuring a time of light shielded by the sheet 1.

[0037] The timing sensor SCO2 detects the front end of the sheet 1 at the moment when the light is shielded.

[0038] The switching gate 5 sorts the conveyed sheets 1.

[0039] The conveying roller 2 and the pinch roller 3 are provided in front of the switching gate 5.

[0040] The reversing portion 10 takes in and reverses the sheets 1 sorted by the switching gate 5.

[0041] The conveying roller 6 and the second conveying path 2 take in the sheets 1 sent from the reversing portion 10 and convey them in the second direction that is the reverse direction to the conveying direction of the first conveying path 4.

[0042] The reversing portion 10 comprises a reversing roller 11 capable of rotating in the normal and reverse directions for taking and reversing the sheets 1 conveyed on the first conveying path 4, the pinch roller 12 arranged opposite to the reversing roller 11, conveying rollers 14 and 15 that are capable of rotating in the normal and reverse directions, and a reversing roller drive motor 13.

[0043] The reversing roller 11 is connected to the reversing roller drive motor 13 and is driven normal or reverse directions by this reversing roller drive motor 13. The reversing roller drive motor 13 is connected to a controller 9 (see FIG. 3).

· [0044] FIG. 3 is a block diagram showing the construction of the control circuit of the reversing controller.

[0045] The output signals from the length sensor SCO1 and the timing sensor SCO2 are input to the controller 9.

[0046] The switching gate 5 is connected to a switching gate driver 8 and driven by this switching gate driver 8. The switching gate driver 8 is connected to the controller 9.

[0047] The switching gate driver 8 rotates the switching gate 5 clockwise when the sheets 1 are conveyed to the reversing portion 10 through the first conveying path 4. Further, the switching gate driver 8 rotates the switching gate 5 counterclockwise when the sheets 1 are conveyed to the second conveying path 7 from the reversing portion 10.

[0048] The controller 9 detects the lengths of the sheets 1 in the conveying direction from the output signal of the length sensor SCO1 and detects the front ends of the sheets 1 from the output signal of the timing sensor SCO2. Further, the controller 9 controls the switching gate driver 8 and rotates the switching gate 5 clockwise or counterclockwise to set the conveying direction of the sheet 1.

[0049] Further, the controller 9 sets up a conveying control parameter 90 in order for setting the rotating velocity in the normal/reverse direction and the rotating velocity in the reverse direction of the reversing roller 11 and the pinch roller 12 of the reversing portion 10.

[0050] Next, using FIG. 4 to FIG. 10, the operation of conveying the sheets 1 through the reverse control will be explained.

[0051] FIG. 4 shows the state of the sheet 1 at the moment when the sheet 1 was conveyed on the first conveying path in the arrow direction A, its rear end passed the length sensor SCO1 and the light from the light emitting element was changed from the shaded state to the acceptable state by the light receiving element. At this time, the controller 9 discriminates whether the sheet 1 has a length suited to the detecting medium and measures the length of the sheet 1 by counting a time of the light shaded in the length sensor SCO1 by the time unit clock.

[0052] Then, when the sheet 1 is suited to a detecting medium, the controller 9 rotates the switching gate 5 clockwise and conveys the sheet 1.

[0053] FIG. 5 is a diagram showing the moment when the front end of the sheet 1 reaches the timing sensor SCO2. Further, timing diagrams showing the relation of subsequent conveying time and velocity are shown in FIG. 10A to FIG. 10C. Here, the controller 9 sets the conveying control parameter 90 that is set according to the above-

mentioned length of the sheet 1 in the reversing roller drive motor 13 and as a result, the reversing roller 11 is rotated in the normal direction. In this case, the rotating velocity ω_0 of the reversing roller 11 is set for the conveying control parameter 90 so that the conveying velocity of the first conveying path 4 agrees with the tangential velocity that is a velocity in the tangential direction of the outer surface of the reversing roller 11 within a time T_0 until the front end of the sheet 1 reaches the nip between the reversing roller 11 and the pinch roller 12.

[0054] FIG. 6 is a diagram showing the moment when the front end of the sheet 1 reaches the nip between the reversing roller 11 and the pinch roller 12. Here, because the front end of the sheet 1 reached the nip between the reversing roller 11 and the pinch roller 12, the rotating velocity is so set that the tangential velocity that is a velocity in the tangential direction of the outer surface of the reversing roller 11 reaches the conveying velocity of the first conveying path 4. The rotating velocity of the reversing roller 11 reached the velocity ω_0 and therefore, the sheet 1 is smoothly taken in the reversing portion 10.

[0055] However, when the tangential velocities of the reversing roller 11 and the pinch roller 12 are not equal to the conveying velocity of the first conveying path 4, a force caused by a difference in conveying velocities is applied to the sheet 1 and the sheet 1 may be damaged.

[0056] Therefore, a one-way roller is used for the conveying roller 2 and when, for example, the tangential velocity at the side of the reversing roller 11 and the pinch roller 12 is fast, the conveying roller 2 is able to run idle. Thus, it becomes possible to prevent the sheet 1 from being damaged.

[0057] In succession, the controller 9 accelerates the rotating velocity of the reversing roller 11 by a specified time T_1 by controlling the reversing roller drive motor 13 based on the conveying control parameter 90 and then, rotates the reversing roller 11 at a rotating velocity ω_1 that is faster than a rotating velocity ω_0 for a specified time T_2 , then decelerates the velocity for a specified time T_3 and stops the reversing roller 11.

[0058] FIG. 7 is a diagram showing the sheet 1 stopped in the state protruded from the reversing roller 11 and the pinch roller 12 by a length L . Here, the sheet 1 is stopped for a certain fixed time T_4 .

[0059] FIG. 8A to FIG. 8D are diagrams showing the length L of the sheet 1 protruding from the reversing roller 11 and the pinch roller 12 by the conveying control in the

embodiment of this invention, respectively. Here, the length L of the sheet 1 protruding from the reversing roller 11 and the pinch roller 12 as a result of the conveying control for changing the conveying control parameter 90 for every sheet 1 of optional length is shown.

[0060] When the length of the sheet 1 shown in FIG. 8A is used as a standard, the length of the sheet shown in FIG. 8B is longer than the length of the sheet 1 shown in FIG. 8B. The length of the sheet 1 shown in FIG. 8D is longer than the length of the sheet 1 shown in FIG. 8C.

[0061] However, in all cases shown in FIG. 8A to FIG. 8D, the conveyance of the sheet 1 is controlled based on the conveying control parameter 90 so that the length L protruding from the reversing roller 11 and the pinch roller 12 becomes constant.

[0062] FIG. 9 shows the state of the sheet 1 that was driven in the reverse direction by the reversing roller 11 and the pinch roller 12 and sent to the second conveying path 7. Here, the reversing roller 11 and the pinch roller 12 are accelerated in the reverse direction for a specified time T_5 so that the tangential velocity of the reversing roller 11 and the pinch roller 12 becomes the rotational velocity $-\omega_2$ faster than the conveying velocity from the stopped state of the sheet. Then, the reversing roller 11 and the pinch roller 12 are rotated at the rotational velocity $-\omega_2$ for a specified time T_6 and decelerated for a specified time T_7 , and after reaching the rotational velocity $-\omega_0$ where the tangential velocity of the reversing roller 11 is turned to the reverse direction at the same size of the conveying velocity of the second conveying path, and this rotational velocity $-\omega_0$ is maintained for a time T_8 until the sheet 1 is completely separated from the reversing roller 11 and the pinch roller 12.

[0063] Also in this case, as explained in FIG. 6, when the tangential velocity of the reversing roller 11 and the pinch roller 12 is not equal to the conveying velocity of the second conveying path 7, a force caused from the difference in the velocities is applied to the sheet 1 and the sheet 1 may be damaged in some cases.

[0064] Therefore, a one-way roller is used for the conveying roller 6 and when the rotational velocity is fast at the reversing roller 11 and the pinch roller 12 side and the sheet 1 is fed at a high velocity, the conveying roller 6 is able to run idle.

[0065] Thus, the sheet 1 is taken into the second conveying path 7.

[0066] FIG. 10A to FIG. 10D are diagrams showing the velocity patterns relative to the control of the reversing roller drive motor 13 when the conveying control parameter 90 is

.set according to a size of the sheet 1. In FIG. 10A to FIG. 10D, ω_0 (rad/S) is a standard rotational velocity of the reversing roller 11.

[0067] T_0 is a time of the rotational velocity of the reversing roller 11 to reach ω_0 .

[0068] T_1 is a time of the rotational velocity of the reversing roller 11 is being accelerated to ω_1 from ω_0 .

[0069] T_2 is a time of the reversing roller 11 rotating at a constant velocity of ω_1 .

[0070] T_3 is a time of the reversing roller 11 being decelerated from the rotational velocity ω_1 to 0.

[0071] T_4 is a time of the reversing roller 11 kept stopped.

[0072] T_5 is a time of the rotational velocity of the reversing roller 11 being accelerated in the reverse direction from

[0073] the rotational velocity 0 to $-\omega_2$.

[0074] T_6 is a time of the reversing roller 11 being rotated at a constant velocity of $-\omega_2$.

[0075] T_7 is a time of the rotational velocity of the reversing

[0076] roller 11 being decelerated from $-\omega_2$ to ω_0 .

[0077] T_8 is a time of the reversing roller 11 rotating at a constant velocity $-\omega_0$.

[0078] At this time, the sheet 1 is sent to the second conveying path 7 at the rotational velocity $-\omega_0$ from the reversing roller 11 and the pinch roller 12.

[0079] FIG. 10A is a velocity pattern diagram relative to the reversing roller drive control of the sheet d 135 that is a 135 mm long sheet 1.

[0080] FIG. 10B is a velocity pattern diagram relative to the reversing roller drive control of the d195 sheet that is a 195 mm long sheet 1.

[0081] FIG. 10C is a velocity pattern diagram relative to the reversing roller drive control of the d255 sheet that is a 255 mm long sheet 1.

[0082] The d195 sheet is longer than the d135 sheet and therefore, the time T_2 rotating at the rotational velocity ω_1 and the time T_6 rotating at the rotational velocity $-\omega_2$ become long. The d255 sheet is longer than the d195 sheet and the time T_2 rotating at the rotational velocity ω_1 and the time T_6 rotating at the rotational velocity $-\omega_2$ become further long.

· [0083] Thus, the sheet 1 having a long length is conveyed at a high velocity while the reversing roller 11 is rotated at a higher rotational velocity (ω_1 at the normal rotation, $-\omega_2$ at the reversing) than the standard rotational velocity (ω_0 at the normal rotation, $-\omega_0$ at the reversing) for a longer time. As a result, the conveying gap between the sheets 1 becomes uniform and the high density conveyance becomes possible.

[0084] FIG. 11 shows the state of plural sheets 1 being conveyed after the reversing while keeping the gap between the sheets before the reversing without changing the conveying pitch. That is, the sheets 1₁, 1₂ and 1₃ having lengths L₁, L₂ and L₃, respectively are conveyed on the first conveying path 4 with the conveying gaps g₁ and g₂. Accordingly, the conveying pitch between the first conveyed sheet 1₁ and the next conveyed sheet 1₂ is L₁ + g₁ and the conveying pitch between the sheet 1₂ second conveyed second and the sheet 1₃ third conveyed is L₂ + g₂. These conveying pitches are equally set. That is, L₁+g₁ = L₂+g₂. The sheets 1₁, 1₂ and 1₃ conveyed on the second conveying path 7 after reversed by the reversing portion 10 are conveyed without changing this conveying pitch.

[0085] As explained above, according to the above embodiment, the longer sheets 1 can be taken into the reversing portion 10 from the first conveying path and fed out into the second conveying path 7 from the reversing portion 10 faster than the shorter sheets 1 and therefore, it becomes possible to convey plural sheets conveyed on the first conveying path 4 so that the conveying gap between plural sheets becomes equal to the conveying gap between plural sheets conveyed on the second conveying path after the reversing. That is, plural sheets 1 are conveyed without changing the conveying gap between plural sheets conveyed on the first conveying path 4 before reversing against the conveying gap between plural sheets conveyed on the second conveying path 7 after the reversing.

[0086] Further, the protruding amount of sheets can be set optionally by the arrangement of the switching gate 5 and the reversing portion 10 and therefore, it is possible to provide a sheet reversing controller capable of high density conveying.

[0087] As explained above, according to this invention, the protruding length of sheets when the sheets are stopped at the reversing portion can be controlled to a fixed length regardless sheet lengths and therefore, the conveying gaps between sheets become constant before and after the reversing and the high density conveying can be realized.

[0088] Further, as the switchback reversing in the high density conveying is enabled, a compact and economical sheet reversing controller can be provided.